

This lesson is part of a larger, comprehensive school garden guide called **Minnesota School Gardens: A Guide to Gardening and Plant Science** developed by Minnesota Agriculture in the Classroom in 2013. The entire guide is available at [www.mda.state.mn.us/maitc](http://www.mda.state.mn.us/maitc).



## Grade

Elementary 3-5

### Materials/Preparation

- ☐ Handout A – Plant Dimensions Chart – one per student
- ☐ Handout B – Plan It, Map It – one per student
- ☐ Seed catalogs or Internet access to seed catalogs
- ☐ Rulers, yardsticks, measuring tapes
- ☐ Paper, graph paper or notebook (or purchase garden planning software to use computers)
- ☐ Writing instruments

### optional

- ☐ Calculators

### Fun Fact

Apple trees take four to five years to produce their first fruit.



# Plan It, Map It

## Minnesota K-12 Academic Standards

Math	3.3.2	Understand perimeter as a measurable attribute of real world and mathematical objects. Use various tools to measure distances.
Math	4.3.2	Understand angle and area as measurable attributes of real world and mathematical objects. Use various tools to measure angles and areas.
Math	5.2.3	Understand and interpret equations and inequalities involving variables and whole numbers, and use them to represent and solve real-world and mathematical problems.
Science	3.4.1.1 5.4.1.1	Living things are diverse with many different characteristics that enable them to grow, reproduce and survive.
Science	5.4.2.1	Natural systems have many parts that interact to maintain the living system.

### Summary/Overview

Using the information provided, students use math skills to plan their garden.

### Garden Connection

Students learn about plant varieties, row width, space between plants, and height.

### Background Information

Living things compete with one another to survive and reproduce. Plants have differing characteristics unique to their species and variety. Even within species there are differences between varieties. Consider the number of different squashes, or the variety of tomato plants. Much of the information in this guide sets standard parameters that plants need. But this can vary. This activity gives students the opportunity to experience first-hand that math has a purpose with real-life applications, research various plant information, and make decisions about the garden they will plan and plant.

### Objectives

- List plant-growing requirements to consider when planning a garden.
- Use simple multiplication to calculate garden rows and size.

## Procedure

### Interest Approach

Have students brainstorm their favorite vegetables. Create a list on the board.

### Summary of Content and Teaching Strategies

#### Groundwork: Spacing Requirements

Have students select vegetable plants they could plant in the garden. Make a list of those plants. Students may refer to the list of favorite vegetables from the Interest Approach above.

Using hard copy seed catalogs or online seed suppliers, ask students to identify the number of varieties of one of these vegetables. Students can work in small groups to find the information on their chosen or assigned vegetable. Provide students with copies of Handout A. They list the names of the varieties available on Handout A. Burpee Seeds online is a good resource for finding this information.

**NOTE:** For plants with more than 10 varieties, have students select a specific type of that vegetable (i.e. tomatoes: select full-sized, slicing tomatoes or heirloom; squash: select winter squash or summer squash; peppers: select sweet bell peppers or hot peppers).

Ask students to identify each variety's growing requirements and note them in the chart provided. Have them select the variety they think is best to plant in the school garden and estimate the number of plants they would like to have.

Next have students calculate the number of square feet their garden will require to grow the number of vegetables they have selected. Students then create a rough-draft map of their garden drawn to approximate scale. The teacher should set the specific scale for the class and determine if the garden will be planted using rows or square foot gardening.

Groups take turns sharing the information on their specific vegetable with the rest of the class.

## Exploration

### Designing the School Garden

Give students the actual school garden dimensions. Share what garden space will be available for their class to use.

Have students determine what and how many of each plant they will incorporate into the garden. Decisions to be made:

1. Will each student have his or her own plant or plants (number)?
2. Will each student have the same type of plant?
3. If so, what will it be? If not, how many total types of vegetables will be grown?
4. Will more than one variety of each vegetable be grown?



As a group, plan the school garden. Consider plant height in relation to the sun to prevent tall plants from shading short plants. Also plan room for humans to weed, water, and harvest the garden.

Instruct students to make a scale drawing of the garden plot. For younger students, plant needs can be depicted graphically by making a paper pattern of the space needed by each plant. Use these patterns to map out the garden in scale size.

## Review/Summary

Have students answer the following questions in small groups:

1. Name three vegetables that can be grown in a garden.
2. Explain why it is important to leave room between plants.
3. Describe why plant height needs to be considered when planning a garden.

## Modifications/Extensions

- Have students create algebraic equations for planning the garden.
- Have students create gardens that incorporate circles, triangles, rectangles, octagons, and create a garden diagram drawn to scale that provides adequate plant space and human working space.
- Have students create three-dimensional gardens that use fencing, wire cages, climbing poles, etc. to make use of vertical as well as horizontal space.



*"Children are born naturalists.  
They explore the world with  
all of their senses, experiment  
in the environment, and  
communicate their discoveries  
to those around them."*

*The Audubon Nature Preschool*

### Sources/Credits

The above lesson is provided courtesy of Florida Agriculture in the Classroom, Inc. from its *Gardening for Grades* school garden curriculum.

Name \_\_\_\_\_



# Plant Dimensions Chart

Vegetable Selected			
Variety	Row Width	Space Between Plants	Height

Name \_\_\_\_\_



# Plan It, Map It

**1.** Name three plants you would like to grow.

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**2.** Select one of those plants and list it below.

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Does this plant have any special needs?

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**3.** How much distance should there be between this plant and the next plant in the same row?

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**4.** If this plant were planted in several rows, how far apart should each of these rows be from the next row?

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**5.** How tall does this plant grow?

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## Grade

Elementary K-3

## Materials/Preparation

- ☐ Handout A – Plant Illustrations – one per student
- ☐ Crayons or markers
- ☐ Scissors
- ☐ Staples, glue sticks or tape
- ☐ Samples of fruits and vegetables that represent different plant parts. (When possible, save one example of each of the following. Wash and cut the rest into bite-sized samples for tasting: fruit or flower – apples, oranges, grapes, kiwi, strawberries, broccoli, cauliflower; seed or flower – peas in a pod, sunflower or pumpkin seed snacks, popcorn; leaf – lettuce; stem – celery; root – carrot, radishes.)
- ☐ Tray for samples
- ☐ Vegetable dip
- ☐ Tub of cream cheese mixed with equal amount of brown sugar for fruit dip
- ☐ Spoons for dips
- ☐ Small paper plates – one per student
- ☐ Napkins – one per student



# Plant Parts Become Me

## Minnesota K-12 Academic Standards

Science	0.4.1.1 1.4.1.1 2.4.1.1	Living things are diverse with many different observable characteristics.
Science	3.4.1.1 5.4.1.1	Living things are diverse with many different characteristics that enable them to grow, reproduce and survive.

## Summary/Overview

Students begin by reviewing the main parts of plants through a role-play activity. They design their own plants and compare the variety of their creations to those of their classmates. Students identify and taste fruits and vegetables that come from different plant parts.

## Garden Connection

Roots, stems, leaves, flowers make up the foods we harvest from gardens.

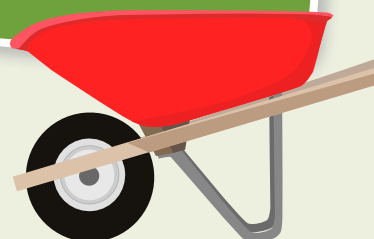
## Background Information

Plants have four basic parts: roots, stems, leaves, and flowers. Roots anchor and support plants as well as absorb nutrients and water. Roots also store excess food produced by the plant. Stems support leaves and flowers. They also act as a transportation system moving water and nutrients up from the roots and taking excess food produced by the plant down to the roots. The main job of leaves is to create food and energy through the process of photosynthesis. Finally, flowers provide plants a way to reproduce. The brightly colored petals attract insects, which aid in pollination. Pollination leads to fertilized eggs that create new seeds.

While each plant part is crucial to the growth and development of the plant, humans also benefit from these parts. The fruits and vegetables we eat come from the four main parts of a plant as well as from the seeds. Edible roots include carrots and radishes. Asparagus, celery, and rhubarb are stems. Lettuce is an edible leaf. Most of the flowers we eat have turned into fruits. Fruits are the fleshy produce containing one or more seeds. Apples, oranges, grapes, kiwi, strawberries, broccoli, and cauliflower are all examples of flowers or flowers that have grown into fruit. Edible seeds include peas in a pod, sunflower or pumpkin seeds, and popcorn.

### Fun Fact

Carrots are members of the parsley family, characterized by the feathery green leaves. Other members include parsnips, fennel, dill, and celery.



## Objectives

- Identify the four parts of plants and their functions.
- Make connections between plants and personal food choices.

## Procedure

### Interest Approach

Guide students in a role-play activity where they pretend to be a plant. Start by pretending that it is spring and you are seeds that have been planted in the ground. Curl up on the floor or “ground” like a seed in our garden. You are underground. The soil or ground is all around you. Spring rains come down and soften the seed coat so that your roots start to grow into the soil.

Ask students, “What part of your body can you use to become roots?”

*Feet and legs are the roots growing out of the seed and pushing down into the soil. Roots are the first plant part to grow out of seeds. Wiggle your toes as your roots start growing out of the seed.*

Ask students, “What part of your body is the stem?”

*Your body is the stem. Wiggle your bottom, shoulders, and elbows. Pop up your head and start growing tall. Stand up tall and straight so that your stem is growing above the ground. (Above ground is the height of desks or tables.)*

Ask students, “What parts of your body could be the leaves and branches?”

*Your arms could be branches and your hands and fingers could be leaves. Put your arms out away from your body and wiggle your hands and fingers as if they were leaves fluttering in the breeze. Reach toward the sky to catch the sun’s rays.*

*Stand up straight with your head held high and a big smile on your face because your head is a beautiful flower on top of a sturdy stem. Move it back and forth like it is enjoying the sunshine and the breeze.*

## Summary of Content and Teaching Strategies

### Groundwork: Designing Plants

Distribute Handout A. Have students look at the pictures on the activity sheet and identify the four parts of a plant. Every picture in the first column is a root. Every picture in the second column shows a stem and leaves. Every picture in the third column is a flower. Explain that flowers develop into fruit that contains seeds.

Provide crayons or markers for students to color pictures of the plant parts on Handout A. Students can design their own plants by carefully cutting out the boxes with the pictures. Mix them up and design a favorite combination to make plants, each with a top, middle, and bottom in the correct order.

After the students have colored, cut, and lined up their plants, they attach the parts in any of the following ways.

Staple or glue them on paint stir sticks so they can carry them around like stick puppets and pretend to plant them in a flowerpot in the room.

- Glue them on colorful construction paper to hang around the room.
- Tape them together in a strip and hang them around the room.

Have students name their new flowers and tell the rest of the class about them. Discuss similarities and differences.

- How many people put the same combinations of flowers, leaves, and roots together?
- How many different combinations do we have?
- How many are exactly the same?

## Exploration

### Edible Parts of Plants

Review the four parts of plants. Make four columns on the board with these headings:

- flowers
- leaves
- stems
- roots

If desired, flowers can be further subdivided into fruits and seeds.



Before the following activity, wash and cut fruit and vegetable plant part samples and put them on a large tray. Prepare the dips for spooning out onto the students' plates.

Ask students what fruits and vegetables they have eaten yesterday and today. Have them list what they ate under columns on the board labeled roots, stems, leaves, and flowers. Explain that fruits and vegetables are important to our health because they contain vitamins and minerals that help keep us healthy. They also contain fiber to help clean out our bodies. Eating a variety of vegetables and fruits of different colors is a healthy eating habit.

Have the students wash their hands in preparation to try some vegetables and fruits. Show them actual samples of roots – an entire carrot; stems – a celery stalk but remind them it is really a leaf stem; leaves – a lettuce leaf; and flowers – an entire apple or orange. Have them guess what they are and what part of a plant they come from. Give each student a small paper plate and a napkin. Show the tray of fruits and vegetables and encourage the students to try at least two to three different fruits and vegetables. Offer ranch dressing and cream cheese mixed with brown sugar to use as dips. The dips may encourage them to try new vegetables and fruits. If choosing is difficult for your students, prepare sample plates for them. Optional: Challenge students to try one root, one stem, one leaf, and one flower.

Discuss and describe the differences in flavor, texture, and color between the root, stem, leaf, and flower.



#### Sources/Credits

Adapted from Growing in the Garden Elementary Curriculum that Grows with the Child written by the Iowa 4-H Development Program and revised in June 2012. The curriculum can be purchased from the Iowa State Extension Office <http://www.extension.iastate.edu/4h/page/curricula-info-ordering>

## Review/Summary

Divide the class into four groups and assign each group one of the foods listed below. Some foods may be assigned to more than one group; add your own food ideas to the list. Students discuss the vegetables or fruits that are in each food and the plant part they come from. Have groups report back to the class. You may want to write the ingredients on the board or provide students with a labeled colored picture of their food.

- **Pizza** – onions (leaves); tomatoes, peppers, olives (fruits); crust (wheat seeds)
- **Hamburger** – onion, lettuce (leaves); tomato, catsup (fruit); mustard (seeds); bun (wheat seeds, sesame seeds)
- **Vegetable soup** – onions, celery (leaves); potato (stem); tomatoes, pepper, peas, beans, okra (fruit); carrots (roots)
- **Spaghetti and sauce** – tomatoes, peppers (fruit); onions (leaves); pasta (wheat seeds)

## Modifications/Extensions

Get "Dirt Made My Lunch or Singing in Our Garden" CD by the Banana Slug String Band ([bananaslugstringband.com](http://bananaslugstringband.com)). After playing the song, ask students to identify the six parts of the plant listed in the song. Ask them what each part is doing in the song.

Read *Stone Soup* by Marcia Brown. Make cards for each vegetable mentioned in the book and distribute to students. As you read, have students bring their cards to the front when each vegetable is read. They can sort the vegetables by plant parts at the front of the room.

Name \_\_\_\_\_



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# Roots, Stems, Leaves, and Flowers

ACTIVITY SHEET  
PLANT PARTS BECOME ME!

4-H Youth Development  
4H-905A3 | Revised June 2012



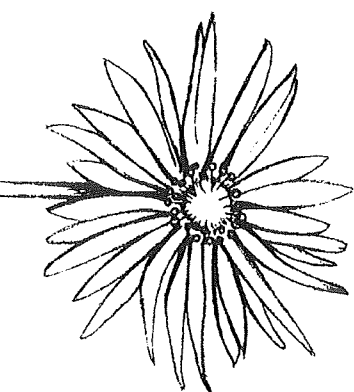
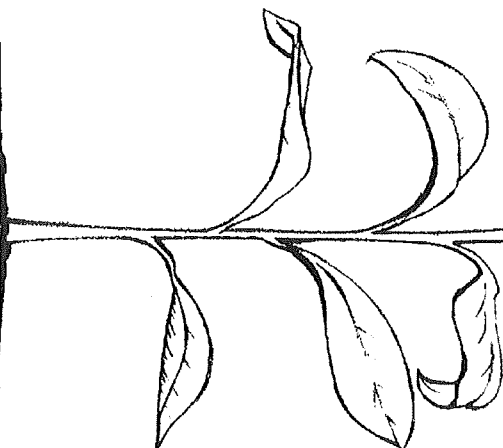
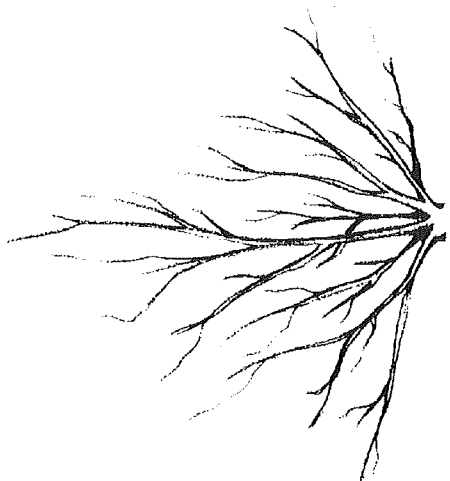
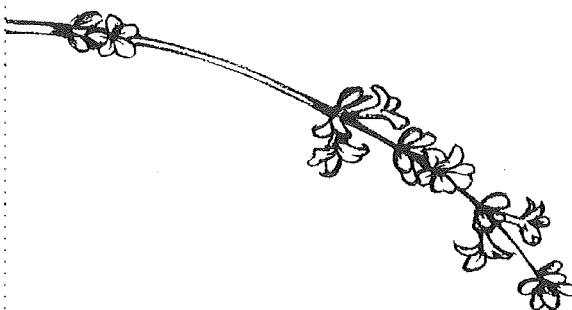
Roots



Stems and Leaves



Flowers



## Grade

Middle School

### Materials/Preparation

- ☐ Teacher Material A – Parts of a Plant – one per teacher
- ☐ Teacher Material B – Edible Plant Parts – one per teacher
- ☐ Handout A – Salad Investigation Report - one per student
- ☐ Assessment A – Salad Investigation – one per student
- ☐ Paring knife
- ☐ Salad ingredients: Enough to make each student one small salad each with seven of the following: carrots, lettuce, tomatoes, sunflower seeds, celery, broccoli, cucumbers, mandarin oranges
- ☐ Plates, napkins, and forks – one set per student
- ☐ Variety of salad dressings
- ☐ Writing utensils

*Before class begins, prepare enough miniature salads for each student in the class to have one. Choose seven plant foods from the Materials list or add your own. Salads should include samples of at least one of each of the six basic plant parts. (Suggestion: have salads prepared and set at each student's individual seat with a fork and napkin). Display Teacher Material A on a large board or suitable wall space.*

# Salad Investigation

## Minnesota K-12 Academic Standards

Science	7.4.1.1	Tissues, organs and organ systems are composed of cells and function to serve the needs of all cells for food, air and waste removal.
Health	6.6.1	The student will apply strategies and skills needed to attain personal health goals.

### Summary/Overview

Students learn about edible plant parts and the difference between fruits and vegetables while eating a salad.

### Garden Connection

Students identify the parts of plants used to make a salad.

### Background Information

Plants are the most important source of food in the world (both for humans and animals). All the fruits, vegetables, and starches we enjoy each day come from the six distinct parts of plants: roots, stems, leaves, flowers, seeds, and fruits. Edible plant parts are classified as either vegetables or fruits. *Vegetables* are any edible part of the plant that is not the fruit. This includes foods that are leaves, roots, stems, flowers, and seeds. Technically, *fruits* that we consume (apples and oranges, for example) are the fruiting body of the plant. Believe it or not, ketchup is a fruit product because it is derived from the fruit of a tomato plant.

### Objectives

- Cite five examples of edible plant parts.
- Explain the difference between fruits and vegetables.

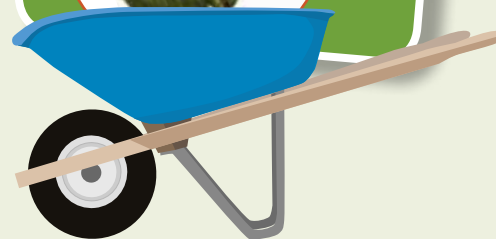
### Procedure

#### Interest Approach

Tell students not to touch the salad, napkin, or fork on their desk. Have them wash their hands. Or you may wish to provide hand-sanitizing gel. Provide students with copies of Handout A. Invite them to be detectives investigating their salad and name the seven different food components on the Salad

#### Fun Fact

An apple is in the pome family – a fruit whose seeds are embedded in the core of the fruit. Another surprising member of this family is the rose.



Investigation Report. Point out the “salad component” section on the worksheet. Provide students with three minutes to complete this one column. Verbally review each component of the salad.

## Summary of Content and Teaching Strategies

Review the parts of the plant. Display Teacher Material A and have students point out the plant parts. Plants are the most important source of food in the world (both for humans and animals). The fruits, vegetables, and starches we enjoy each day come from different parts of the plants. These foods are all one of the six main plant parts: roots, stems, leaves, flowers, seeds, and fruits.

Discuss the difference between fruits and vegetables. Decide whether each of the salad foods is a fruit or vegetable, and what part of the plant it is. Ask students to do this activity in pencil so they can go through each one and correct any answers that need to be rethought. Invite them to add other foods that come from this same part of the plant.

Discuss commonly misnamed fruits and vegetables. There is a simple way to remember the difference. Vegetables are any edible part of the plant that is not the fruit. This includes foods that are leaves, roots, stems, flowers, and seeds. Discuss information on **Teacher Material B**. Point out these plant parts on **Teacher Material A**. Discuss the vegetables and fruits students listed on their Salad Investigation Reports. The reports should now be completed. Provide salad dressing and invite students to eat their salad.



## Review/Summary

Have students answer the following questions in small groups:

1. What part of the plant is lettuce?
2. Is a cucumber a fruit or vegetable? (Fruit; seeds are inside)
3. Name an example of a vegetable. (Lettuce, carrots, turnips, lima beans, etc.)
4. Is ketchup a fruit or vegetable product? (Fruit because it comes from tomatoes, which are the fruit of the tomato plant.)

## Modifications/Extensions

Have students do a fanciful Complete Salad Plant activity. Students draw single plants that could be a complete salad; their parts are made of the foods discussed in the lesson (carrots, lettuce, tomatoes, sunflower seeds, celery, broccoli, cucumbers, mandarin oranges). Students label each plant part with the name of the food and which of the six basic plants is represented (for example: lettuce leaves, carrot roots). Have students share their drawings with classmates. Post these in the classroom as a fun reminder of the origins of their salad.

Challenge students to use the knowledge they gained from this lesson to write three healthy eating goals for themselves. The goals should relate to eating a variety of healthy foods and include foods from each plant part.



### Sources/Credits

Adapted from: National FFA Organization Middle School Food and Agricultural Literacy Curriculum, sponsored by the National Pork Board as a special project of the National FFA Foundation. Visit [www.ffa.org/documents/learn/MS.PS.1.3.pdf](http://www.ffa.org/documents/learn/MS.PS.1.3.pdf) to access the full length version of this lesson.



# Parts of a Plant

## Leaves Functions:

1. Site of photosynthesis
2. Absorbs sunlight to produce energy
3. Site of the majority of transpiration

## Flower Functions:

1. Site of reproduction
2. Contain male and/or female parts
3. Can be bright and fragrant to attract pollinators

## Stems Functions:

1. Channel of water, nutrient, and sugar transportation throughout the plant
2. Supports buds and leaves

## Fruit Functions:

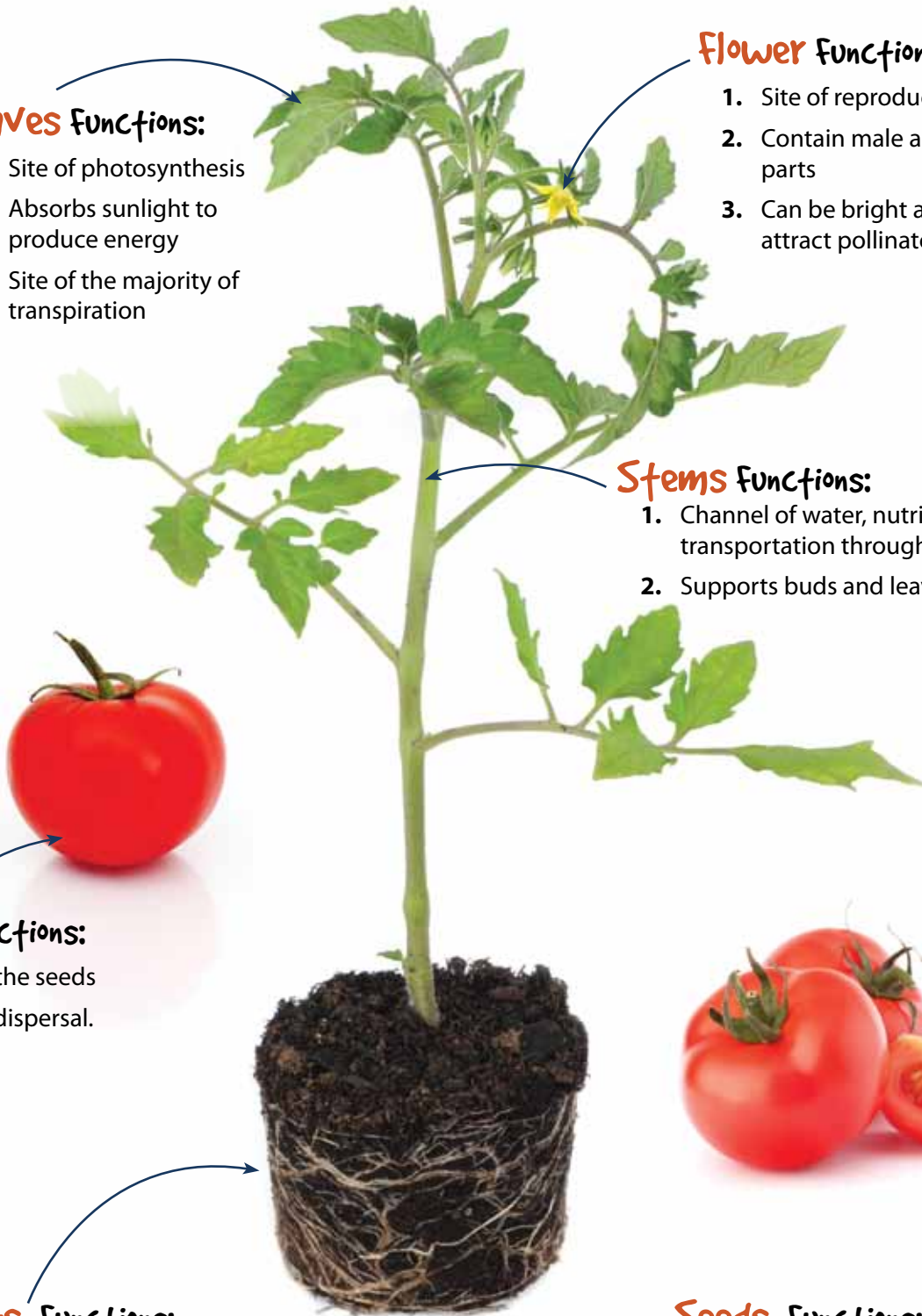
1. Protect the seeds
2. Help in dispersal. How?

## Roots Functions:

1. Absorb water and minerals from the soil
2. Anchor plant to ground
3. Support stem structure

## Seeds Functions:

1. Contain the embryo which will become new plants





# Edible Plant Parts

**A.** Plants are the most important source of food in the world (both for humans and animals). The fruits, vegetables, and starches we enjoy each day come from different parts of the plants. All these foods are one of the six main plant parts: roots, stems, leaves, flowers, seeds, and fruits. Edible plant parts are classified as either vegetables or fruits.

**B. Vegetables:** Vegetables are any edible part of the plant that is not the fruit. This includes foods that are leaves, roots, stems, flowers, and seeds.

1. **Roots:** Roots collect water and minerals from the soil. Roots are also used for energy and food storage for some plants. Examples of edible roots include carrots, beets, turnips, and rutabaga.
2. **Stems:** Stems transport water and minerals from the roots to the rest of the plant and transport the energy created by photosynthesis from the roots to the rest of the plant. Commonly eaten stem parts include celery, onions, and potatoes. Potatoes are actually modified stems that plants use to store energy, which is why they are such a great source of energy.
3. **Leaves:** Leaves are the primary site of photosynthesis in plants. They are also the site of transpiration. Leaves are a great source of many vitamins needed for healthy humans and animals. Commonly consumed leaf foods include lettuce, kale, spinach, cabbage, collards, and mustard greens.

4. **Flowers:** Flowers are the reproductive structure in plants and can contain male (stamen) and/or female (pistil) structures. Flowers are usually the flashiest part of the plant in order to attract pollinators. Many flowers are common foods for humans including broccoli and cauliflower.
5. **Seeds:** Seeds are the mature ovules that are originally found in the female part of the flower and are usually housed in a type of fruit or cone. Seeds contain the embryo, which will germinate and become a new plant. Common edible seeds include lima beans, peas, sunflower seeds, green beans, and pinto beans.

**C. Fruits:** Technically, fruits that we consume (apples and oranges, for example) are the fruiting body of the plant..

Fruits are formed from the fertilized ovule (seeds) and the ovary walls of the female part of the flower. The fruit protects the seed and assists in the dispersal of seeds (by attracting animals that may consume the fruit and disperse the seed). Edible fruits include apples, oranges, and strawberries. Although they are often called vegetables, tomatoes and cucumbers are also the fruit of the plant.

## Vocabulary Words

**Ovules:** small eggs found in the female part of the flower

**Photosynthesis:** the process by which plants use energy from the sun, carbon dioxide, and water to make food

**Pollinator:** an agent that transfers flower pollen from the male anthers to the female stigma

**Transpiration:** water evaporation from leaves

Name \_\_\_\_\_



# Salad Investigation Report

As we explore the components of our salads, fill in the following chart. **First**, list the seven components. **Second**, determine whether the food is a vegetable or fruit and write a V or F in the box. **Third**, name what part of the plant it is (root, stem, leaves, flowers, fruit, or seeds). Finally, list 3-4 examples of other plant foods that are from the same part of the plant as the component.

Salad component	Fruit or Vegetable?	Part of Plant	other Foods from this Plant Part



# Salad Investigation

Determine whether each food is a fruit or vegetable. In the third column, name the part of the plant the food is. Use the list of basic plant parts below.

Plant Parts					
Root	Stem	Leaves	Flower	Seed	Fruit

Name of Food	Fruit or Vegetable	Plant Part
Turnip Greens	1.	2.
Carrots	3.	4.
Lima Beans	5.	6.
Tomato	7.	8.
Celery	9.	10.
Broccoli	11.	12.

## Grade

Middle School

### Materials/Preparation

- ☐ Teacher Material A – Mind Map Example – one per teacher
- ☐ Assessment A – Importance of Plants – one per student
- ☐ Computer
- ☐ Poster paper
- ☐ Notebook paper
- ☐ Magazines
- ☐ Scissors
- ☐ Glue
- ☐ Writing Utensils
- ☐ Markers
- ☐ Food for Thought Desk Map\*

\*The Food for Thought Desk Map is available online at [www.mda.state.mn.us/Global/MDADocs/kids/food4thought/deskmap11x17.aspx](http://www.mda.state.mn.us/Global/MDADocs/kids/food4thought/deskmap11x17.aspx). Printed maps can be ordered from Minnesota Agriculture in the Classroom.

### Fun Fact

Carrots have a higher natural sugar content than all other vegetables with the exception of beets.



# Importance of Plants

## Minnesota K-12 Academic Standards

Science	7.4.3.2	Individual organisms with certain traits in particular environments are more likely than others to survive and have offspring.
Social Studies	5.3.1.3	Places have physical characteristics (such as climate, topography and vegetation) and human characteristics (such as culture, population, political and economic systems).
Social Studies	7.3.1.1 8.3.1.1	People use geographic representations and geospatial technologies to acquire, process and report information within a spatial context.

### Summary/Overview

Students learn about the importance of plants and create a mind map to display the ways in which plants influence their lives. Next they use a thematic map to help understand why crops grow in specific areas of the state.

### Garden Connection

Students explore some factors that influence plant growth.

### Background Information

Plants impact our daily lives. Students may not realize how many products they use contain plants. This lesson opens their eyes to the importance of plants. In order to effectively grow the plants we use so often, it is helpful to know what influences plant growth. Landforms, annual precipitation, annual frost-free days, and native vegetation all play a role in where farmers and gardeners choose to grow certain crops in Minnesota. Students review maps of these factors and compare them to maps showing growing areas of four major crops.



### Objectives

- List five ways humans use plants.
- Explain factors that influence crop production.
- Identify important crops grown in Minnesota.
- Analyze why crops are grown in specific areas of Minnesota.

## Procedure

### Interest Approach

As students enter the room, have them write one way they have used plants during the day on the board. After everyone has shared, review the answers as a class. Ask how the answers might be categorized. As a class, develop categories. Examples: food, fiber, building materials, oxygen, medicine, beauty, and economic value. Help students think of any areas that might be missing.

### Summary of Content and Teaching Strategies

#### Plant Uses

On notebook paper, instruct students to create the outline of a mind map for the importance of plants. See Teacher Material A for a sample outline. Use categories developed by the class or example categories.



Divide the class into groups assigning each group a plant use category. Each group makes a poster with a list of plants and plant materials that belong in their category. Next groups should add pictures or magazine clippings illustrating items found in their category. Students may need to research their topic using a computer. Have each group share their findings with the class. Students note the findings on their mind maps.

#### Sources/Credits

This lesson was developed for the Minnesota Garden Guide.

### Factors Influencing Growth

Understanding factors that influence plant growth is critical for a successful harvest. Ask students to brainstorm a list of things they think affect plant growth. Be sure they include landforms, annual precipitation, annual frost-free days, and native vegetation on their lists. Discuss how different plants require different kinds of growing conditions to thrive.

Utilize Minnesota Agriculture in the Classroom's (MAITC) Food for Thought maps and curriculum to investigate Minnesota's plant growth factors.

### Plants in Minnesota

Next ask students to name and list important agricultural crops grown in Minnesota. For each crop, ask students to develop a hypothesis as to why these crops grow in each particular area of Minnesota.

Again consult MAITC's Food for Thought maps and curriculum to discover Minnesota plant growth locations and conditions.

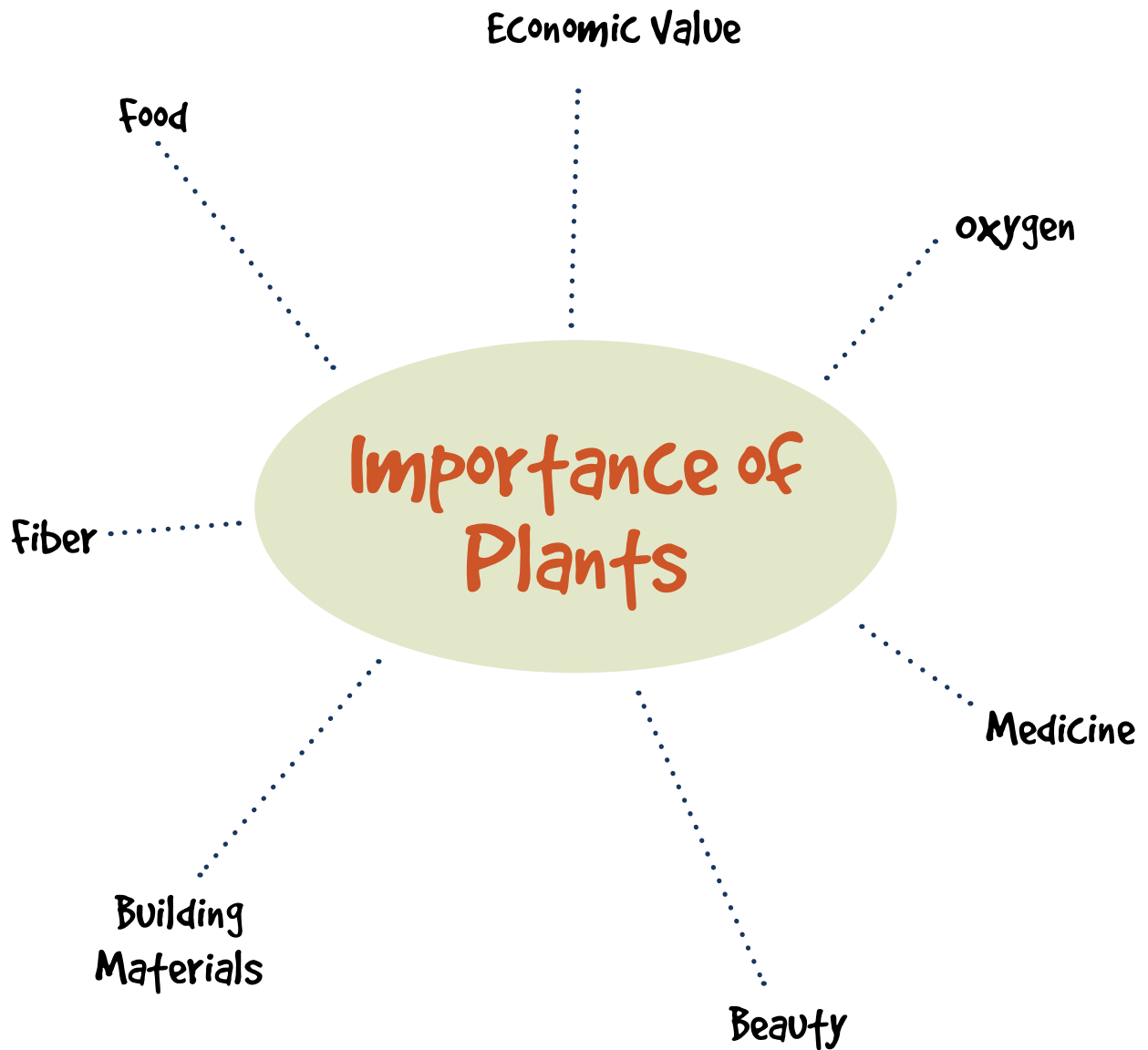
### Review/Summary

Ask students to name three uses of plants they learned about during the lesson. Discuss the hypotheses they developed while looking at the maps of Minnesota.

### Modifications/Extensions

Utilize lessons from the Food for Thought Mapping Curriculum *Connecting Minnesota Geography, Agriculture and Communities* available from Minnesota Agriculture in the Classroom. [www.mda.state.mn.us/kids/food4thought.aspx](http://www.mda.state.mn.us/kids/food4thought.aspx)





Name \_\_\_\_\_



# Importance of Plants

1. List five ways humans use plants.

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2. Name two factors that influence crop production.

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3. Identify two important crops grown in Minnesota.

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4. Explain why some crops are grown in northern Minnesota and others are grown in southern Minnesota.

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## Grade

High School

## Materials/Preparation

- ☐ Teacher Material A – Plants in Our World – one per teacher
- ☐ Handout A – Surrounded by Plants – one per student
- ☐ Assessment A – Surrounded by Plants – one per student
- ☐ Computers with Internet access and ability to print
- ☐ Colored pencils
- ☐ Notebooks
- ☐ Map of U.S. from the 50states.com website
- ☐ USDA Agricultural Census Data from USDA website <http://www.agcensus.usda.gov>

### Fun Fact

It takes about 36 apples to create one gallon of apple cider.



# Surrounded By Plants

## Minnesota K-12 Academic Standards

Science	9.4.2.1	The interrelationship and interdependence of organisms generate dynamic biological communities in ecosystems.
Science	9.4.4.1	Human activity has consequences on living organisms and ecosystems.
Social Studies	9.3.1.1	People use geographic representations and geospatial technologies to acquire, process and report information within a spatial context.

## Summary/Overview

In an effort to connect students with the key idea of plant importance for human life, Surrounded by Plants begins by asking students to survey their home and neighborhood for plant products they encounter in daily life.

## Garden Connection

Plants harvest energy from the sun and provide us with many usable products.

## Background Information

Plants are vital to all life on Earth. They mean survival. Plants are the base of food for all humans and animals. They can harvest energy from the sun and exchange gas. (Plants use carbon dioxide from the air and convert it into oxygen.) Plants use the energy from sunlight to convert raw materials from the Earth into carbohydrates, fats, and oils. Humans depend on plant materials for food, feed for livestock, fiber, fuel, medicine, aesthetic value, and much more.



Plants are affected by environmental factors, including frost-free periods or growing season, mean average temperature or growing degree days, and rainfall. These factors create unique growing conditions across the United States and throughout the world.

## Objectives

- Identify why plants are critical for all life on Earth.
- List plant products found in your everyday world.
- Explain why certain plants are grown in certain regions of the United States.
- Compare and contrast the growing conditions in Minnesota to other areas of the country.

## Procedure

### Interest Approach

Ask student to think about the many times a day they touch or eat things that come from plant materials. Our world consists of an unimaginable number of products originating with plants. Students are likely touching several as they sit in a chair and take notes in their notebooks. Plants are a major part of daily life in several forms. As a class, make a list of plant products found in the classroom.

### Summary of Content and Teaching Strategies

Present and discuss Teacher Material A. Have students brainstorm examples for each of the ways humans use plant material.

Distribute a copy of Handout A to each student. Review the handout and answer any questions. Have students complete the triangle in Figure 1. Part 2 of the activity is for students to research the common growing regions for one crop from each category in Figure 1. The directions instruct students to print off a United States map from the 50states.com website at <http://www.50states.com/maps/print/usamap.htm>. Using this map, students shade growth regions using colored pencils for one crop from each use category. Use a different color for each crop and label the colors in a map legend. Students must incorporate the TODALS (title, orientation, date, author, legend and scale) map basics into the map they create.

For forestry products, the USDA Forest Service database is provided: [http://www.srs.fs.usda.gov/pubs/misc/misc\\_reston.pdf](http://www.srs.fs.usda.gov/pubs/misc/misc_reston.pdf).

Students will need to research medicinal crops separately. The following are common medicinal crops to consider providing to students who need assistance in this category:

- aloe
- Echinacea
- Saint John's Wort
- aspirin
- ginkgo
- castor bean
- hemp

Once Part 2 is completed, students access hardiness zone and precipitation websites to determine the climate correlations to the production regions shaded on their maps. This activity provides an understanding of why certain crops are grown in certain regions due to their dependence upon climate conditions. Find information on hardiness zones in the Teacher Information for Chapter 2 on page 53.

### Review/Summary

Have students share their completed maps with the class and explain two things they learned during the activity.

### Modifications/Extensions

Get a large wall chart of the United States and have each student add different crops to it in order to summarize crop-growing regions of the United States. Next have students research the social, economic, and ecological risks and benefits of changing a natural ecosystem as a result of human activity. Ask them how these changes might influence crop-growing regions in the future.

Students have researched environmental factors that affect where plants grow. Take this idea a step further and investigate how carrying capacity influences the population of particular plants. After further research, ask students to describe factors that affect the carrying capacity of an ecosystem and relate these to population growth.



### Sources/Credits

Adapted from: *Curriculum for Agricultural Science Education (2012) Principles of Agricultural Science – Plant*. [Curriculum materials for secondary agricultural education instruction.] Lexington, KY.

Parker, R. (2010). *Plant and soil science: Fundamentals and applications*. Clifton Park, NY: Delmar. An *Introduction to Plant Science* is found on pages 174-184 and additional information on climate data is found on pages 247-257.

# Plants in our world

**Plants are vital to all life on Earth for two reasons:**

1. Harvesting the Sun: Plants use the energy from sunlight to convert raw materials from the Earth into carbohydrates, fats, and oils.
2. Gas Exchange: Plants use carbon dioxide from the air and convert it into oxygen. The process of food production and gas conversion is called photosynthesis.

## Human Value

**What are some ways humans use plant material?**

1. Food
2. Feed for livestock
3. Fiber
4. Fuel
5. Medicine
6. Aesthetic value

## Crop Regions

**Certain crops grow in specific regions of Minnesota and the United States. Influencing environmental factors include:**

1. Frost free periods (growing season)
2. Mean average temperature (growing degree days)
3. Rainfall



Name \_\_\_\_\_



# Surrounded by Plants

## Part 1. Survey Personal Plant Exposure

Survey your home and neighborhood to determine the plant products you are exposed to every day. Complete the lists for the categories of plant products in Figure 1.

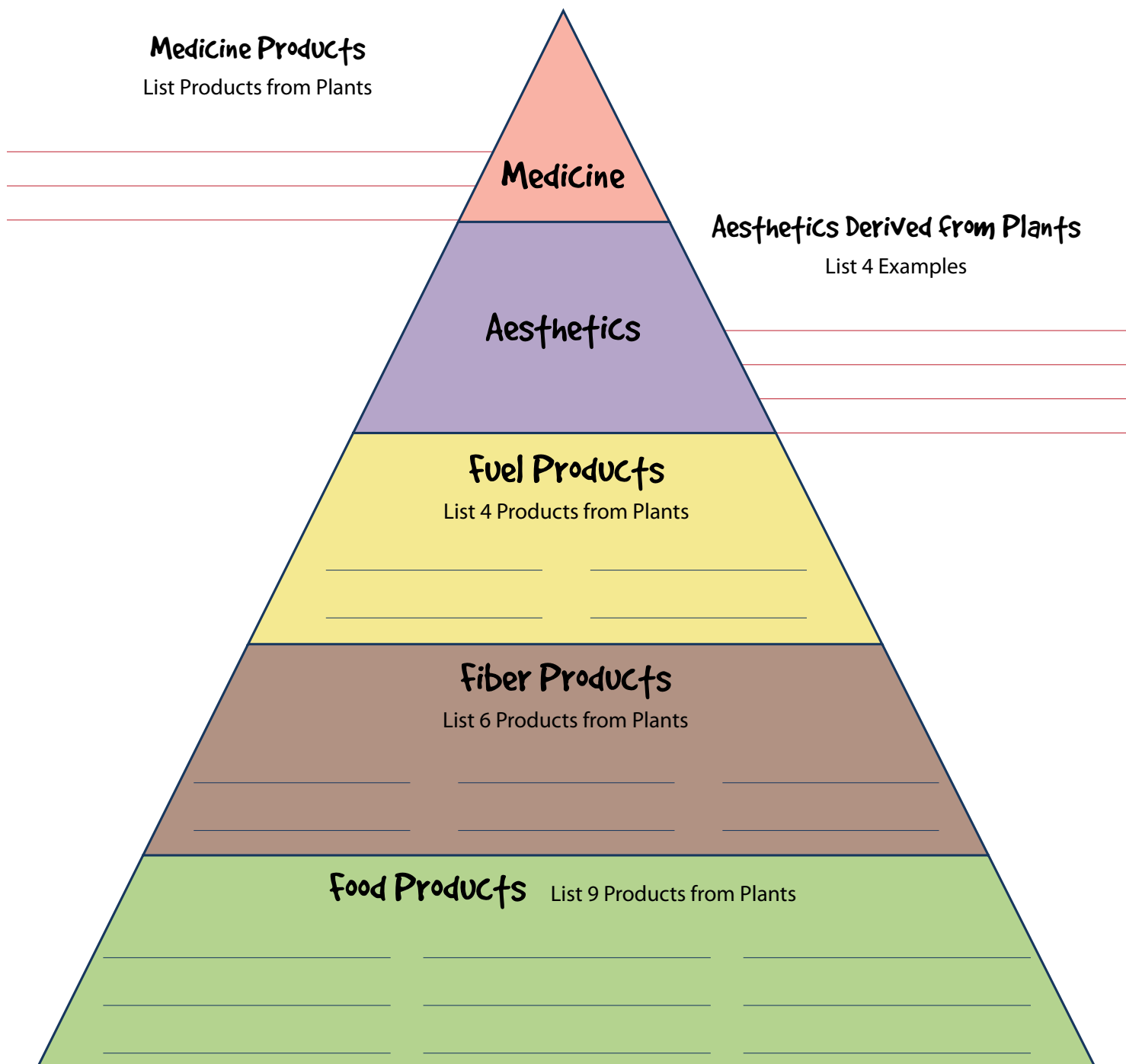


Figure 1. Crop Commodity Triangle

## Part 2. Identify Crop Regions

1. Use the USDA Census website to locate the growing regions for ONE CROP from EACH CATEGORY listed in Figure 1.
2. Print off the map of the United States from the 50states.com website at <http://www.50states.com/maps/print/usamap.htm> and use it as the template.
3. Shade in the growing region of each crop using a specific color of pencil to indicate each crop. Include a key on the map to identify which color represents each crop.

For crop growing region, view the USDA 2007 Agriculture Census data:

[http://www.nass.usda.gov/research/2007mapgallery/album/Crops\\_and\\_Plants/Field\\_Crops\\_Harvested/index.html](http://www.nass.usda.gov/research/2007mapgallery/album/Crops_and_Plants/Field_Crops_Harvested/index.html)

For information related to forestry products, use the following URL:

[http://www.srs.fs.usda.gov/pubs/misc/misc\\_reston.pdf](http://www.srs.fs.usda.gov/pubs/misc/misc_reston.pdf)

## Part 3. Identify Growing Conditions

Once your map of crop growing regions is complete, use the following websites to investigate what environmental influences, such as temperature and rainfall, affect plant production.

For plant hardiness zones, view the following website:

<http://www.usna.usda.gov/Hardzone/ushzmap.html>

For rainfall data related to crop regions, see the NRCS website:

<http://www.wcc.nrcs.usda.gov/climate/prism.html>

## Conclusion

1. What environmental factors have the greatest effect on determining regions for crop production?  

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2. What are the predominant crops grown in Minnesota?  

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3. Explain how growing conditions in Minnesota compare to the southwestern part of the United States.  

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4. Why do you suspect a large number of cattle and hogs are raised in the Midwest United States?  

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5. List two plant products that you feel do not fit into any of the categories identified on the pyramid.  

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Name \_\_\_\_\_



# Surrounded by Plants

1. Explain how plants “harvest” energy from the sun.

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2. Name two ways humans use plants.

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3. List two environmental factors influencing plants.

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4. How do the growing conditions in Minnesota compare to those in other parts of the country?

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## Grade

High School

### Materials/Preparation

- ☐ Handout A – Garden Goals – one per student
- ☐ Handout B – Action Plan – one per student
- ☐ Assessment A – Planning a Garden – one per student
- ☐ Writing utensils
- ☐ Computers (optional)
- ☐ Refer to Chapter One Teacher Information as needed on page 13.

### Fun Fact

The World's Longest Carrot, recorded in 2007, was 19 feet 1 7/8 inches (5.839 meters) long.



# Garden Goals

## Minnesota K-12 Academic Standards

Language Arts	9.9.1.1b	Work with peers to set rules for collegial discussions and decision-making (e.g., informal consensus, taking votes on key issues, presentation of alternate views), clear goals and deadlines, and individual roles as needed.
Language Arts	11.9.1.1b	Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed.
Language Arts	9.9.4.4	While respecting intellectual property, present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task (e.g., persuasion, argumentation, debate).
Language Arts	11.9.4.4	While respecting intellectual property, present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks (e.g., persuasion, argumentation, debate).

## Summary/Overview

Students take ownership in the school garden by creating goals and planning for success.

## Garden Connection

A successful garden requires planning and goal setting.



## Background Information

Whether it is a trip, a birthday party, or a garden, the planning stage takes time, can be a lot of fun, and is a necessary step in ensuring success. Dreaming of the many possibilities and selecting favorites can be very exciting. As you plan your school garden, be sure to include the students in as much of the process as possible. The more the students are involved in decisions, the more they feel ownership in the project.

## Objectives

- List three goals your school has for the garden.
- Create a garden design.
- Explain why the class selected a specific garden design.
- Make a list of activities and projects related to the garden.

## Procedure

### Interest Approach

Discuss different types of school gardens. Review the examples of school gardens in Minnesota listed after the Introduction in this guide (pages 6-9). Encourage students to note the differences in size and scope. Start a discussion about what kinds of gardens might work at your school.

### Summary of Content and Teaching Strategies

Provide students with a copy of Handout A. Students complete the worksheet as you discuss each area.

#### Goals

Discuss each of the four key areas and why they are important parts of a school garden: outdoor classroom, student involvement, healthy eating, and community connections. Ask students to write down a goal for each of the four key areas as described in the Chapter One Teacher Information on page 13. When finished, they share their goals with a partner. Next ask pairs to list their goals on the board. As a class, come to a consensus on which goals to adopt.

#### Design

With the adopted goals in mind, what is the best design for your school garden? Have students brainstorm a list of possible garden designs. Gardens range from growing a few plants indoors near a window to a large in-ground vegetable garden. Help students select a garden design with a size and scope appropriate to your school. If this is the first year your school has had a garden, start small. Your garden can expand over the next several years.

#### Activities/Projects

Create a list of activities to do in the garden and projects related to the growing of plants. Brainstorm what skills and information students will learn from growing their plants. Examples of activities to be done in the garden include planting, weeding, watering, and harvesting. A project related to growing plants is to research recipes using herbs grown in a classroom window. Or, if you will be growing vegetables in a

large quantity to sell, have students research different methods of selling produce including Community Supported Agriculture (CSA) or farmers' markets.

As a class, develop an action plan to accomplish the goals of the garden. What steps need to be completed in order to get your plants started, maintain plants over the growing period, and harvest the crop? Include timelines and assign a lead person for each task.



If your schedule allows, evaluate the garden at the end of the project. Discuss what students learned from the experience, what went well and what could be improved.

### Review/Summary

Discuss the following questions as a class or ask students to journal their responses.

1. Why is it important to create a plan for the garden?
2. What part of the garden are you most excited about?

### Modifications/Extensions

Provide students with graph paper to map out the school garden to scale. Be sure they take into account spacing between plants and rows and allow for walkways. Maps should include a legend as well as indicate the scale used.

#### Sources/Credits

This lesson was developed for the Minnesota Garden Guide.

Name \_\_\_\_\_



# Garden Goals

## Brainstorm

## Adopted By Class

Garden goals	<p>outdoor classroom</p> <p>student involvement</p> <p>healthy eating</p> <p>community connections</p>	<p>outdoor classroom</p> <p>student involvement</p> <p>healthy eating</p> <p>community connections</p>
Garden design		



## Brainstorm

## Adopted By Class

Garden activities/projects		
Plants to grow in the garden		

Name \_\_\_\_\_



# Action Plan

Task	Timeline	Lead Person	others Helping

Name \_\_\_\_\_



# Garden Goals

Create a brochure or PowerPoint presentation highlighting the different aspects of the school garden to be shared with administration, teachers, school board members, parents, and community groups. Be sure to include all items listed in the grading rubric.

	Points Possible	Grade
<b>Content</b>		
Goals	10	
Design	10	
Activities/Projects	10	
<b>Appearance</b>		
Pictures	5	
Creative	5	
Well organized	5	
Use of class time	5	
<b>Total</b>	50	

Include a scanned copy of the garden design.

# Selection of Crops and Garden Themes

## Chapter 2

## Teacher Information

### Crop Selection in Minnesota

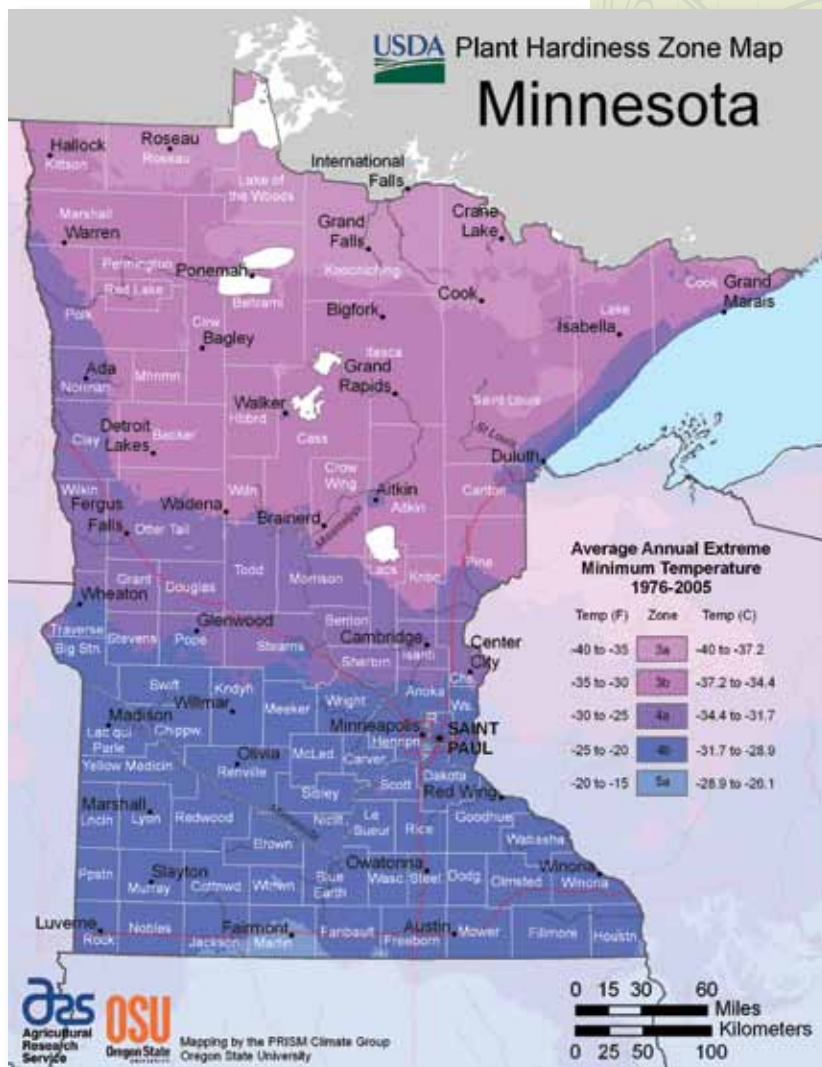
When choosing crops, there are several items to consider. Be sure to check the mature height of plants as well as the distance between plants and rows. If plants are too crowded they may not grow to maturity and produce quality fruit or vegetables. Next, determine if the plant is a warm or cool season crop. It is also important to note how and when to start plants. Some need to be started indoors and later transplanted while others can be seeded directly into the garden. Harvest dates are also vital to note, as you need to be prepared to remove produce from the garden. Finally, be sure to find out if the crop can grow in Minnesota climate. For some crops, Minnesota summers are not long enough to allow them to reach maturity.

### Cool-Season and Warm-Season Crops

Cool-season crops are able to tolerate colder temperatures and can be planted earlier than warm-season crops. Examples of cool-season vegetables are lettuce, cabbage, cauliflower, broccoli, Brussels sprouts, and onions. Warm-season crops, including tomatoes, eggplant, and peppers, should not be planted outside until after frost danger in mid-to-late May. Some plants can be started indoors or in a greenhouse and later transplanted outdoors.

### Starting Plants

Plants can be grown in two ways: direct seeding and transplanting. Direct seeding is when seeds are planted in their final destinations. This method works well for faster-growing flowers and vegetables. Slower-growing flowers and vegetables do better when they are started indoors and later transplanted or moved to their final destinations. Many gardens use both methods of planting. Read seed packets and refer to the chart on pages 54-56 to determine the best method for the plants you have selected.



## USDA Plant Hardiness Zone Map - Minnesota

Source <http://planthardiness.ars.usda.gov/PHZMWeb/#>

The United States Department of Agriculture (USDA) has developed a map to assist gardeners when selecting plants. The map reflects the average extreme minimum temperature by zone using data from 1976-2012. Gardeners use zone information to select plants that thrive in their climate. This is especially important for perennial plants that over-winter.

## Planting Dates and Distances for Garden Vegetables

Vegetable	Planting Dates		Planting Distances (in inches)			
	Start seed indoors	Plant seed or plant outdoors	Between rows, hand cultivated	Between plants	Depth of seeding (inches)	Amount to order per 20 feet of row
Asparagus		April 15 - May 1 (crowns)	36	12 - 18	6 - 8	15 crowns
Beans, snap (bush)		May 15 - July 1	18 - 24	3 - 4	1½ - 2	3 - 4 oz.
Beans, snap (pole)		May 15 - July 1	36	4 - 6	1½ - 2	2 - 3 oz.
Beans, dry shell		May 15	18 - 24	3 - 4	1½	3 - 4 oz.
Beans, lima		May 15 - June 10	18 - 24	4 - 6	1½	3 - 4 oz.
Beets		April 15 - July 1	12 - 18	2 - 4	½ - 1	1 packet
Broccoli	March 1 - 15	April 15 or June 1	24 - 30	24	¼ (indoors)	1 packet or 9 plants
Brussels sprouts	March 1 - 15	April 15 or June 1	24 - 30	24	¼ (indoors)	1 packet or 9 plants
Cabbage, early	March 1 - 15	April 1 - May 1	24 - 30	18	¼ (indoors)	1 packet or 12 plants
Cabbage, late	April 15 - May 1	June 1	24 - 30	24	¼ (seedbed)	1 packet or 9 plants
Cabbage, Chinese		July 1	24 - 30	18	½	1 packet
Carrots		April 15 - June 15	18 - 24	2 - 3	¼	1 packet
Cauliflower	March 1 - 15	April 15 or June 1	24 - 30	18 - 24	¼ (indoors)	1 packet or 12 plants
Celery	Feb. 15 - March 1	May 15	18 - 24	8	1/8 (indoors)	1 packet or 24 plants
Chard, Swiss		May 1	18 - 24	6 - 8	1	1 packet
Collards		April 15	24 - 36	6	¼	1 packet

*"Packet" refers to average commercially-packaged seed packet.*

Vegetable	Planting Dates		Planting Distances (in inches)			
	Start seed indoors	Plant seed or plant outdoors	Between rows, hand cultivated	Between plants	Depth of seeding (inches)	Amount to order per 20 feet of row
Cucumbers		May 1 - June 15	48 - 60	12 between single plants; 36 between hills of three	1	1 packet
Eggplant	March 15 - April 1	June 1	24 - 30	24	¼ (indoors)	1 packet or 9 plants
Endive		April 15	18 - 24	8 - 12	½	1 packet
Garlic		Oct. 1 - Nov. 1	18 - 24	4 - 6	3 - 4	1 lb. of cloves
Horseradish		April 15 - May 1	24 - 30	12 - 18	6 (roots)	18 roots
Kale		April 15 - July 15	18 - 24	12 - 18	½	1 packet
Kohlrabi		April 15 - June 1 or Aug. 1 - 15	18 - 24	6	½	1 packet
Lettuce, leaf		April 15 - June 1 or Aug. 1 - 15	12 - 18	4 - 6	¼	1 packet
Lettuce, head	March 1 - 15	April 15 - May 1	18 - 24	12	¼ (indoors)	1 packet or 18 plants
Muskmelon		May 15 - June 1	60 - 72	18	1	1 packet
Okra	March 15 - April 1	June 1	24 - 36	12 - 15	½ (indoors)	1 packet
Onion seeds		April 15	12 - 24	2	½	1 packet
Onion, transplants	Feb. 1 - 15	April 15	12 - 24	2 - 3	½ (indoors)	1 packet
Onion, sets		April 15	12 - 24	2 - 3	1 - 2	½ lb.
Parsley		April 15 - May 1	12 - 24	4 - 6	¼	1 packet
Parsnips		May 1 - 15	18 - 24	3 - 4	½	1 packet
Peas		April 10 - May 15	18 - 24	2	1½	1 packet
Pepper	March 15 - April 1	June 1	24 - 36	18 - 24	½ (indoors)	1 packet or 12 plants
Potatoes, Irish		April 15 - June 1	24 - 30	12 - 18	4 (each piece)	3 lbs. seed potatoes
Potatoes, sweet	April 15 (roots)	June 1	36 - 48	18 - 24		9 - 12 plants
"Packet" refers to average commercially-packaged seed packet.						



Vegetable	Planting Dates		Planting Distances (in inches)			
	Start seed indoors	Plant seed or plant outdoors	Between rows, hand cultivated	Between plants	Depth of seeding (inches)	Amount to order per 20 feet of row
Pumpkin		May 10 - June 1	72 - 96	24 - 36 between single plants; 60 - 72 between hills of three	1 - 2	1 packet
Radish		April 10 - June 1 or Aug. 1 - 15	6 - 12	1 - 2	½	1 packet
Rhubarb		April 15 - May 1	36 - 48	36 - 48		5 or 6 plants
Rutabaga		May 15 - June 15	18 - 24	8 - 12	½	1 packet
Spinach		April 15 or Aug. 1 - 15	12 - 18	3 - 4	½	1 packet
Squash, summer		May 10 - June 1	24 - 36	24 - 36	1	1 packet
Squash, winter		May 10 - June 1	72 - 96	24 - 36 between single plants; 60 - 72 between hills of three	1	1 packet
Sweet corn		May 10 - July 1	30	12	1 - 2	1 packet
Tomato	April 1 - 15	May 15 - June 1	24 - 36	36 - 48	¼ (indoors)	1 packet or 6 - 8 plants
Turnip		April 15 or Aug. 1	15 - 18	3 - 4	½	1 packet
Watermelon		May 15 - June 1	60 - 72	24 - 36 between single plants; 60 - 72 between hills of three	½	1 packet
"Packet" refers to average commercially-packaged seed packet.						

**Source:** <http://www.extension.umn.edu/distribution/horticulture/dg1422.html>

Information on growing flowers in Minnesota can be found on the University of Minnesota Extension website at <http://www1.extension.umn.edu/garden/yard-garden/flowers/>.

## Types of Gardens

Gardens come in many shapes and sizes. The goals of your garden and resources available help you determine what type of garden is best for your school.

### Container Gardens

Smaller garden projects work well in containers. Criteria for an effective container include ability to hold soil, holes in the bottom for drainage, and enough room for root growth. Suggested containers include pots, plastic totes, bushel baskets, and wooden barrels. If you are planting edible crops, be sure toxic materials have not contaminated the container. Larger containers need less frequent watering and fertilizing. Select a good potting soil to fill containers. Garden soil is often too heavy and becomes compact when used in a container.



### Raised Beds

In a raised bed garden, soil is raised above its surroundings. The bed is contained within a structure between six inches and waist high. Raised beds are most often constructed of wood but can be made of rock or concrete block. Raised beds for children are typically no more than three feet wide, allowing students to reach the middle. Advantages of raised beds include clearly defined garden space, loose soil that is better for root growth, ability to warm quickly in spring, and well-drained soil. In addition, plants are less likely to be stepped on by students. Raised beds are also more handicap accessible.



### In-Ground Beds

Before preparing a site for an in-ground bed, dig several samples of soil and have it tested. Testing is available from the University of Minnesota's Soil Testing Laboratory, visit their website for more information <http://soiltest.cfans.umn.edu/>. If soil tests are acceptable, the next step is tilling. Tilling introduces air into the soil, making it easier to plant and easier for plants to grow. Soil that is too wet or too dry should not be tilled. To determine if soil has the proper amount of moisture, form a handful of soil into a ball. If the moisture is correct, the ball will hold its shape but easily fall apart when touched. Compost and fertilizer may be added to soil during the tilling process. Newly started gardens need more than one tilling before planting. In-ground beds require the removal of grass.

### Hydroponics

Hydroponics is a method of growing plants with nutrient-rich water instead of soil. A growing medium such as rock wool or clay pellets is used to anchor the roots. Systems can be set up in a classroom with grow lights, allowing students to have a gardening experience in the winter. Other advantages of hydroponics include a controlled pest environment, easier harvest, and ability to recycle water. Schools interested in using a hydroponic system are advised to find a hydroponic grower in the area who can provide assistance and troubleshooting.

Grade

High School

### Materials/Preparation

- ☐ Teacher Material A – A Plant's Grocery Store – one per teacher
- ☐ Teacher Material B – Part 1 – Determine Pounds of Nutrient per Pounds of Fertilizer – one per teacher
- ☐ Handout A – Fertilizer Figures – one per student
- ☐ Assessment A – Fertilizer Figures – one per student
- ☐ Fertilizer labels
- ☐ Food labels
- ☐ Calculators
- ☐ Notebooks
- ☐ Writing instruments

### Fun Fact

The potato was the first vegetable to be grown in space!



# Fertilizer Figures

## Minnesota K-12 Academic Standards

Math	9.2.4	Represent real world and mathematical situations using equations and inequalities involving linear, quadratic, exponential and nth root functions. Solve equations and inequalities symbolically and graphically. Interpret solutions in the original context.
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### Summary/Overview

Students learn how to calculate the amount of fertilizer in a bag and fertilizer application rates.

### Garden Connection

Students learn how to calculate the amount of fertilizer required by plants.

### Background Information

Successful plant producers understand how to calculate fertilizer rates. Fertilizer nutrient content is always expressed by numbers with primary nutrients listed first in a specific order of nitrogen, (N) phosphorus, (P) and potassium (K). The values are expressed as percentages of nutrient content for the formulation in that bag or container. Other numbers beyond the first three represent other macronutrients, such as sulfur. If micronutrients are included, these nutrients and their percentages are clearly identified in the guaranteed analysis section on the package.

Dry commercial fertilizers are sold in bags or other smaller containers by the pound to nursery managers and gardeners. For field crops, dry fertilizer is sold in larger bags or in bulk. Pricing for commercial fertilizer is typically done on a tonnage basis. This means producers must know how to calculate how much fertilizer they need and compare sources of fertilizer on a tonnage basis to determine the lowest price.

Liquid or water-soluble fertilizers are common for greenhouse operations because of automated systems that apply fertilizer and water at the same time. Liquid fertilizers are normally calculated by parts per million (ppm). This activity has students work through some of the situations gardeners, homeowners, and farmers face as they determine plant nutrient needs and how to meet those needs.



## Objectives

- List three sources of plant nutrients.
- Compare and contrast organic and chemical fertilizers.
- Explain the meaning of the numbers on a fertilizer bag.
- Use mathematical formulas to solve problems regarding fertilizer analyses, rates, and cost comparisons.

## Procedure

### Interest Approach

Show students labels from packages of fertilizer and food. Discuss how the ingredients on a food label are listed from largest to smallest amount. Ask students if they know what the numbers on a fertilizer package mean. (They indicate the percent of nutrients in the bag.) More information on the fertilizer label is provided later in the lesson.

### Summary of Content and Teaching Strategies

Present and discuss information on Teacher Material A with students. Students take notes in their notebooks.

Provide students with copies of Handout A. This activity challenges students with various mathematical problems related to fertilizer calculations for product analysis, rates of application, and cost comparisons. Students will need to review their notes from Teacher Material A. You will need to review the correct formulas and example problems to help students solve the problems provided. Use Teacher Material B for grading purposes.

## Review/Summary

Discuss the conclusion questions found on Handout A.

### Answer to question four on Assessment A:

$$\begin{array}{r} \frac{1 \text{ lb. of N}}{1000 \text{ ft}^2} \times \frac{100 \text{ lbs. of fertilizer}}{18 \text{ lbs. of N}} = \frac{100 \text{ lbs. of fertilizer}}{18,000 \text{ ft}^2} \text{ or } \frac{0.0056 \text{ lbs. of fertilizer}}{1 \text{ ft}^2} \end{array}$$

$$\begin{array}{r} \frac{.0056 \text{ lbs. of fertilizer}}{1 \text{ ft}^2} \times 1000 \text{ ft}^2 = 5.56 \text{ lbs. of fertilizer} \end{array}$$

## Modifications/Extensions

Invite a crop farmer to visit with the class about fertilizer use. Topics to discuss could include soil analysis, calculating fertilizer required, cost, and application. The use of GPS units and computers in crop farming is another fascinating topic.

### Sources/Credits

Adapted from *Curriculum for Agricultural Science Education (2012) Principles of Agricultural Science – Plant*. [Curriculum materials for secondary agricultural education instruction]. Lexington, KY.

# A Plant's Grocery Store

## Sources of Plant Nutrients

### Organic Fertilizers

Manure and compost are examples of organic amendments.

- Animal manure contains nitrogen (N), phosphorus (P), and potassium (K)
- Compost can raise organic matter in the soil and reduce pathogens

### Legumes

- Legumes fix nitrogen, which means they convert nitrogen in the atmosphere into nitrogen that is usable to the plant
- Legumes such as peas, beans, soybeans, alfalfa and peanuts improve the soil they are grown in rather than depleting macronutrients like most crops
- Often legumes are double cropped, which means they are planted after a nitrogen-depleting crop has been harvested

### Synthetic Fertilizers

Synthetic fertilizers use inorganic compounds to concentrate desired nutrients.

Benefits of synthetic fertilizers are:

- Easy to apply
- Can be concentrated
- Readily available
- Can be specifically formulated to meet plant needs

Disadvantages include

- Cost is expensive
- Many are petroleum based

Synthetic fertilizers come in different forms. Examples are:

- Dry (granular or pelleted)
- Liquid
- Water Soluble powder

### What the Numbers Mean

- The first three numbers of a fertilizer analysis are always in order of N-P-K and they stand for the percentage of each nutrient found in the analysis. Example:
- A bag of 10-20-15 means the bag contains 10% nitrogen, 20% phosphorus, 15% potassium



## Let's do some math...

How much nitrogen is in a 100 lb.-bag of 15-16-17 fertilizer?

**Answer: 15 lbs.**

$$15\% \times 100 = .15 \times 100 = 15 \text{ lbs.}$$

## A little harder one...

How much phosphorus is in a 50 lb. bag of 15-16-17 fertilizer?

**Answer: 8 lbs.**

.16 x 50 = 8 or set up the formula:

$$\frac{\text{Value of Nutrient from Fertilizer}}{100 \text{ lbs.}} = \frac{\text{X lbs. of Nutrient}}{\text{lbs. of Fertilizer}}$$
$$\frac{16 \text{ lbs. of P}}{100 \text{ lbs. of Fertilizer}} = \frac{\text{X lbs. of P}}{50 \text{ lbs. of Fertilizer}}$$

Cross multiply to solve for X lbs. of phosphorus(P):

$$16 \times 50 = 100X \text{ this equals } 800 = 100X$$

$$\frac{800}{100} = X$$

$$8 = X \text{ Therefore, 8 lbs. of P}$$

## Try one more...

How much potassium is in a 5 lb. bag of 20-10-20 fertilizer?

$$\frac{20 \text{ lbs. of K}}{100 \text{ lbs.}} = \frac{\text{X lbs. of K}}{5 \text{ lbs. of Fertilizer}}$$

Cross multiply to solve for X lbs. of potassium:

$$20 \times 5 = 100x \text{ this equals } 100 = 100x$$

$$\frac{100}{100} = X$$

$$1 = x \text{ Therefore, 1 lb. of K}$$

## Calculating Fertilizer Application Rates

You need to know how many pounds of fertilizer to apply in order to get enough nutrients to a plant.

Pounds of fertilizer = Application rate x N, P, or K in fertilizer

$$\frac{\text{X lbs. of fertilizer}}{\text{ft}^2} = \frac{\text{lbs. of nutrient}}{\text{ft}^2} \times \frac{100 \text{ lbs. of fertilizer}}{\text{N, P, or K number on fertilizer}}$$

## References

Parker, R. (2010). *Plant and soil science: Fundamentals and applications*. Clifton Park, NY: Delmar. d

Plaster, Edward J., (1992). *Soil science and management (2<sup>nd</sup> Ed.)*. Albany, NY: Delmar.

## Let's try a rate calculation...

You want to add fertilizer to a family member's yard.

- They have 1000 square feet of lawn
- Recommended amount of nitrogen application is 1 lb. /1000 sq. ft.
- The fertilizer you have is 16-8-12

How much **nitrogen** fertilizer should you apply?

### Set up the formula:

Pounds of fertilizer = Application rate x N, P, or K in fertilizer

$$\frac{\text{X lbs. of fertilizer}}{\text{ft}^2} = \frac{1 \text{ lb. of N}}{1000 \text{ ft}^2} \times \frac{100 \text{ lbs. of fertilizer}}{16 \text{ lbs. of N}} = \frac{100 \text{ lbs. of fertilizer}}{16,000 \text{ ft}^2}$$
$$\frac{100 \text{ lbs. of fertilizer}}{16,000 \text{ ft}^2} = .00625 \text{ lbs. of fertilizer/ ft}^2$$

$$\frac{.00625 \text{ lbs. of fertilizer}}{\text{ft}^2} \times \frac{1000 \text{ ft}^2}{\text{(lawn area)}} = 6.25 \text{ lbs. of fertilizer for the lawn}$$

## Calculations Depends on Form

- Dry fertilizers are expressed in weight measurements
- Liquid or water soluble fertilizers are expressed in parts per million (ppm)

## Fertilizer Cost

Cost can be confusing...

- Why does a 100-lb. bag of 20-20-20 cost twice as much as a 100-lb. bag of 10-10-10?

Nutrient content is based on percentage; 20-20-20 has twice as much nutrient value as 10-10-10.

## Fertilizer Figures Activity on Handout A

The Fertilizer Figures activity lets you to practice these calculations. You will determine:

- Pounds of nutrient per pound of fertilizer
- Fertilizer application rates
- Liquid fertilizer application rates in ppm
- Fertilizer costs



## Part I. Defermine Pounds of Nutrient per Pounds of Fertilizer

For the fertilizer sources listed in Table 1, determine the pounds of each nutrient in the container:

Table 1. Fertilizer Nutrient Content				
Analysis of Fertilizer	Weight	Lbs. of N	Lbs. of P	Lbs. of K
Container mix of 15-16-17	100 lbs.	15	16	17
Urea 46-0-0	50 lbs.	23	0	0
Complete fertilizer 20-20-20	25 lbs.	5	5	5
Miracle Gro® All Purpose 24-8-16	5 lbs.	1.2	0.4	0.8
Flowering mix 5-21-18	1 lb.	.05	.21	.18

Show how you set up the formula to calculate the values of each nutrient in Table 1:

$$\frac{\text{Value of N-P-K from Fertilizer}}{100 \text{ lbs.}} = \frac{X \text{ lbs. of Nutrient}}{\text{Lbs. of Fertilizer}}$$

$$\frac{15 \text{ lbs. of N}}{100 \text{ lbs.}} = \frac{X}{100}$$

$$15 \times 100 = 100x$$

$$1500 = 100x$$

$$1500/100 = 100x/100$$

$$15 = X$$

$$15 \text{ lbs. of N}$$

## Part 2. Determine Fertilizer Rates

Fertilizer in a granular form can be applied to field crops, lawns, and gardens. The following problems are provided to determine practical situations involving fertilizer rate calculations. Some helpful formulas:

$$\text{Area} = \text{Width} \times \text{Length}$$

$$\text{Pounds of fertilizer} = \text{Application rate} \times \text{N, P, or K in fertilizer}$$

$$\frac{\text{X lbs. of fertilizer}}{\text{ft}^2} = \frac{\text{lbs. of nutrient}}{\text{ft}^2} \times \frac{100 \text{ lbs. of fertilizer}}{\text{N, P, or K number on fertilizer}}$$

$$1 \text{ ton} = 2000 \text{ lbs.}$$

**Table 2. Fertilizer Rate calculations per Square Feet**

Size of Area	Nutrient Rate Needed	Fertilizer Analysis	Amount of Fertilizer
10' x 100' garden	1 lb. of N per 1000 sq. ft.	16-8-4	6.25 lbs.
50' x 80' lawn	2 lbs. of N per 1000 sq. ft.	16-16-16	50 lbs.
75' x 125' playground	1 lb. of N per 1000 sq. ft.	20-10-20	46.88 lbs.
150' x 360' football field	3 lbs. of N per 1000 sq. ft.	46-0-0	352.17 lbs.

Show the formula and the steps you used to solve the problems in Table 2:

Example "50' X 80' lawn" in Table 2.

$$\frac{\text{X lbs. of fertilizer}}{\text{ft}^2} = \frac{2 \text{ lb. of N}}{1000 \text{ ft}^2} \times \frac{100 \text{ lbs. of fertilizer}}{16 \text{ lbs. of N}} = \frac{200 \text{ lbs. of fertilizer}}{16,000 \text{ ft}^2}$$

$$\frac{200 \text{ lbs. of fertilizer}}{16,000 \text{ ft}^2} = .0125 \text{ lbs. of fertilizer/ft}^2$$

$$\frac{.0125 \text{ lbs. of fertilizer}}{\text{ft}^2} \times \text{lawn area} = \text{fertilizer for the lawn}$$

$$\text{Lawn area} = \text{length} \times \text{width} = 50 \text{ ft} \times 80 \text{ ft} = 4000 \text{ ft}^2$$

$$\frac{.0125 \text{ lbs. of fertilizer}}{\text{ft}^2} \times 4000 \text{ ft}^2 = 50 \text{ lbs. of fertilizer}$$

**Table 3. Fertilizer Rate calculations per Acre**

Size of Area	Nutrient Rate Needed	Fertilizer Analysis	Amount of Fertilizer (lbs.)	Amount of Fertilizer (tons)
6-acre nursery plot	45 lbs./acre of P	16-16-18	1688 lbs.	.84 tons
20-acre field of oats	72 lbs./acre of N	20-10-20	7200 lbs.	3.6 tons
15-acre pasture	60 lbs./acre of N	46-0-0	1957 lbs.	.98 tons
180-acre field of corn	35 lbs./acre of K	15-16-17	37,059 lbs.	18.5 tons

Show the formula and the steps you used to solve the problems in Table 3:

Determine total pounds needed for field size:

$$6 \text{ acres} \times 45 \text{ lbs./acre} = 270 \text{ lbs.}$$

$$\frac{16}{100 \text{ lbs.}} = \frac{270}{X \text{ lbs. of Fertilizer}}$$

$$16x = 27,000$$

$$16x/16 = 27,000/16$$

$$X = 1688 \text{ lbs.}$$

Convert to tonnage:

$$1688/2000 = .84 \text{ tons}$$

## Part 3. Calculating ppm Fertilizer Rates

Liquid or water-soluble fertilizers are mixed to create a desired concentration expressed in parts per million (ppm). Nutrient requirements for greenhouse plants are typically listed in ppm rates. The following are a few scenarios involving ppm problems. Some helpful formulas:

**For a dilution ratio of 1:100 = 1 oz. per 100 gal.**

**You use:**

**% of nutrition in fertilizer x 75 = ppm in 1 oz./100 gal.**

$$\frac{\text{ppm Desired}}{\text{ppm in 1 oz./100 gal.}} = \text{Ounces of fertilizer needed per 100 gallons of water}$$

Table 4. Fertilizer Rates in ppm			
Crop	Rate Needed	Fertilizer Analysis	ounces of fertilizer needed per 100 gal of water
Bedding plants	100 ppm of N	15-16-17	8.89 oz.
Hanging basket	150 ppm of N	20-9-20	10 oz.
Poinsettias	250 ppm of K	20-10-20	16.67 oz.
Chrysanthemums	100 ppm of P	15-10-30	13.33 oz.

Show the formula and the steps you used to solve the problems in Table 4:  
Example for "Bedding plants" in Table 4.

Convert fertilizer percentage to a decimal:

$$15\% = .15$$

$$.15 \times 75 = 11.25 \text{ ppm in 1 oz./100 gal.}$$

$$100/11.25 = 8.89 \text{ oz.}$$

## Part 4. Determine Cost Comparison for Fertilizer

Profit margins on greenhouse plants and crops can be slim depending upon the market. Producers try to limit the cost of inputs in an effort to increase profits. To have a sustainable garden, we need to be smart about purchasing fertilizer and other necessities for ensuring healthy plants.

Fertilizers are formulated at different nutrient ratios depending upon specific growing conditions for the plants. It takes a little knowledge of fertilizers and some calculating to sort out which fertilizers are the best buy.

**Some helpful formulas:**

$$\frac{\text{Percent of N from Fertilizer}}{100 \text{ lbs.}} = \frac{X \text{ lbs. of N}}{\text{Lbs. of Fertilizer}}$$

$$\frac{\text{Price per unit of fertilizer}}{\text{Lbs. of N/Unit of Fertilizer}} = \text{Cost of N/lb.}$$

Base your decision on **nitrogen (N)** content.

**Table 5. Price comparisons of fertilizers**

Your choice	Product A	Price for Product A	N cost/lb. Product A	Product B	Price for Product B	N cost/lb. Product B
A	46-0-0	\$278/ton	\$.30	46-0-0	\$7.50/50 lb. bag	\$.33
B	32-8-8	\$6.75/50 lb. bag	\$.42	45-8-12	\$6.99/ 50 lb. bag	\$.31
A	Sewage sludge	\$45/ton	\$.40	Cattle manure	\$20/ton	\$1.67
Either	16-16-16	\$3.85/50 lb. bag	\$.48	Poultry manure	\$30/ton	\$.48

Show the formula and the steps you used to solve the problems in Table 5:  
Example for Row 1 in Table 5.

**Product A**

$$\frac{46}{100 \text{ lbs.}} = \frac{X \text{ lbs. of Nutrient}}{2000 \text{ lbs. or 1 ton}}$$

$$46 \times 2000 = 100x$$

$$92,000 = 100x$$

$$92,000/100 = 100x/100$$

$$x = 920 \text{ lbs. of N}$$

$$\frac{\$278}{920} = \$ .30 \text{ of N/lb.}$$

**Product B**

$$\frac{46}{100 \text{ lbs.}} = \frac{X \text{ lbs. of Nutrient}}{50 \text{ lbs.}}$$

$$46 \times 50 = 100x$$

$$2300 = 100x$$

$$2300/100 = 100x/100$$

$$x = 23 \text{ lbs. of N}$$

$$\frac{\$7.50}{23} = \$ .33 \text{ of N/lb.}$$

**Product A is the better value.**

## Conclusion

1. A gardener is confused about fertilizer information. The gardener purchased a 25-pound bag of 20-10-20 fertilizer, but does not understand how there could possibly be 20 pounds of nitrogen, 10 pounds of phosphorus, and 20 pounds of potassium in this 25-pound bag. How many actual pounds of N-P-K are in the bag and why was the gardener incorrect in his or her calculations?

*There are 5 pounds of nitrogen and potassium and 2.5 pounds of phosphorus in the 25-pound bag of fertilizer. The gardener did not understand the values for N-P-K are percentages and not actual pounds.*

2. How do organic fertilizers such as manures compare to chemical fertilizers?

*The majority of organic fertilizers do not have a very high concentration of N-P-K.*

3. Why is it important to understand the percentage of nutrients in fertilizer?

*Percentages allow you to determine the rate of application and cost comparisons.*





# Fertilizer Figures

Work through the following scenarios to determine nutrient content of a fertilizer, amount of fertilizer needed, and product comparisons. Refer to specific calculation formulas that you recorded in your notes from Teacher Material A Plant's Grocery Store.

## Part 1. Determine Pounds of Nutrient Per Pounds of Fertilizer

For the fertilizer sources listed in Table 1, determine the pounds of each nutrient in the container.

Table 1. Fertilizer Nutrient Content					
Analysis of Fertilizer		Weight	Lbs. of N	Lbs. of P	Lbs. of K
1	Container mix of 15-16-17	100 lbs.			
2	Urea 46-0-0	50 lbs.			
3	Complete fertilizer 20-20-20	25 lbs.			
4	Miracle Gro® All Purpose 24-8-16	5 lbs.			
5	Flowering mix 5-21-18	1 lb.			

Show how you set up the formula to calculate the values of each nutrient in Table 1.

## Part 2. Determine Fertilizer Rates

Fertilizer in a granular form can be applied to field crops, lawns, and gardens. The following problems are provided to determine practical situations involving fertilizer rate calculations. You need to calculate area in order to compute fertilizer needs. Remember the "N" represents nitrogen. Some helpful formulas:

$$\text{Area} = \text{Width} \times \text{Length}$$

$$\text{Pounds of fertilizer} = \text{Application rate} \times \text{N, P, or K in fertilizer}$$

$$\frac{\text{X lbs. of fertilizer}}{\text{ft}^2} = \frac{\text{lbs. of nutrient}}{\text{ft}^2} \times \frac{100 \text{ lbs. of fertilizer}}{\text{N, P, or K number on fertilizer}}$$

$$1 \text{ ton} = 2000 \text{ lbs.}$$

**Table 2. Fertilizer Rate Calculations (in square footage)**

	Size of Area	Nutrient Rate Needed	Fertilizer Analysis	Amount of Fertilizer
<b>1</b>	10' x 100' parking strip	1 lb. of N per 1000 sq. ft.	16-8-4	
<b>2</b>	50' x 80' lawn	2 lbs. of N per 1000 sq. ft.	16-16-16	
<b>3</b>	75' x 125' playground	1 lb. of N per 1000 sq. ft.	20-10-20	
<b>4</b>	150' x 360' football field	3 lbs. of N per 1000 sq. ft.	46-0-0	

Show the formula and the steps you used to solve the problems in Table 2.

**Table 3. Fertilizer Rate Calculations (for acreage)**

Size of Area		Nutrient Rate Needed	Fertilizer Analysis	Total Amount of Fertilizer (lbs.)	Total Amount of Fertilizer (tons)
1	6-acre nursery plot	45 lbs./acre of P	16-16-18		
2	20-acre field of oats	72 lbs./acre of N	20-10-20		
3	15-acre pasture	60 lbs./acre of N	46-0-0		
4	180-acre field of corn	35 lbs./acre of K	15-16-17		

Show the formula and the steps you used to solve the problems in Table 3.

## Part 3. Calculating ppm Fertilizer Rates

Liquid or water-soluble fertilizers are mixed to create a desired concentration expressed in parts per million (ppm). The nutrient requirements for greenhouse plants are typically listed in ppm rates. The following are a few scenarios involving ppm problems. Some helpful formulas:

For a dilution ratio of 1:100 = 1 oz. per 100 gal.

You use:

% of nutrition in fertilizer x 75 = **ppm in 1 oz./100 gal.**

$$\frac{\text{ppm Desired}}{\text{ppm in 1 oz./100 gal.}} = \text{Ounces of fertilizer needed per 100 gallons of water}$$

**Table 4. Fertilizer Rates in ppm**

Crop		Rate Needed	Fertilizer Analysis	Ounces of fertilizer needed per 100 gal of water
1	Bedding plants	100 ppm of N	15-16-17	
2	Hanging basket	150 ppm of N	20-9-20	
3	Poinsettias	250 ppm of K	20-10-20	
4	Chrysanthemums	100 ppm of P	15-10-30	

Show the formula and the steps you used to solve the problems in Table 4.

# Part 4. Determine Cost Comparison for Fertilizer

Profit margins on greenhouse plants and crops can be slim depending upon the market. Producers try to limit the cost of inputs in an effort to increase profits. One way to do this is buying smart when searching for inputs, such as fertilizer. If we want to have a sustainable garden we also need to be smart about purchasing fertilizer and other necessities for ensuring healthy plants.

Fertilizers are formulated at different nutrient ratios depending upon specific growing conditions for the plants. It only takes a little knowledge of fertilizers and some calculating to sort out which fertilizers are the best buy.

Some helpful formulas:

$$\frac{\text{Percent of N from Fertilizer}}{100 \text{ lbs.}} = \frac{\text{X lbs. of N}}{\text{Lbs. of Fertilizer}}$$
$$\frac{\text{Price per unit of fertilizer}}{\text{Lbs. of N/Unit of Fertilizer}} = \text{Cost of N/lb.}$$

Circle the letter (A or B) of the product that is the best buy.  
Base your decision on **nitrogen (N)** content.

Table 5. Price comparisons of Fertilizers							
Your Choice		Product A	Price for Product A	N Cost/lb. Product A	Product B	Price for Product B	N Cost/lb. Product B
1	A or B	46-0-0	\$278/ton		46-0-0	\$7.50/50 lb. bag	
2	A or B	32-8-8	\$6.75/50 lb. bag		45-8-12	\$6.99/ 50 lb. bag	
3	A or B	Sewage sludge	\$45/ton		Cattle manure	\$20/ton	
4	A or B	16-16-16	\$3.85/50 lb. bag		Poultry manure	\$30/ton	

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Show the formula and the steps you used to solve the problems in Table 5.

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## Conclusion

1. The gardener is confused about fertilizer information. The gardener purchased a 25-pound bag of 20-10-20 fertilizer, but does not understand how there could possibly be 20 pounds of nitrogen, 10 pounds of phosphorus, and 20 pounds of potassium in this 25-pound bag. How many actual pounds of N-P-K are in the bag and why was the gardener incorrect in his/her calculations?

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2. How do organic fertilizers such as manures compare to chemical fertilizers?

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3. Why is it important to understand the percentage of nutrients in fertilizer?

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Name \_\_\_\_\_



# Fertilizer Figures

1. What are two of the three sources of plant nutrients?

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2. Explain the difference between organic and chemical fertilizers.

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3. If a fertilizer bag says 10-10-10, what do these numbers mean?

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4. You want to add fertilizer to your yard.

- You have 1000 square feet of lawn
- Recommended amount of nitrogen application is 1 lb. /1000 sq. ft.
- The fertilizer you have is 18-12-10

How much nitrogen fertilizer should you apply?

Pounds of fertilizer = Application rate x N, P, or K in fertilizer

$$\frac{\text{X lbs. of fertilizer}}{\text{ft}^2} = \frac{\text{lbs. of nutrient}}{\text{ft}^2} \times \frac{100 \text{ lbs. of fertilizer}}{\text{N, P, or K number on fertilizer}}$$